

REMARKS

Preliminarily, Applicants respectfully request the Examiner to return an initialed copy of Form PTO/SB/08A&B (modified) for the Information Disclosure Statement filed March 16, 2004. A courtesy copy of the subject sheet is enclosed.

Claim 4 has been amended to delete awkward language and to correct a spelling error. Claim 9 has been amended to include the article "the" before housing. Other amendments to claims 1 and 9 will be discussed below.

Responsive to the objection to the disclosure, the Abstract has been amended to replace "comprises" with --includes--.

Review and reconsideration on the merits are requested.

Claims 1-10 were rejected under 35 U.S.C. § 103(a) as being unpatentable over JP 59-85932 (JP '932) in view of JP 59-60237 (JP '237). The Examiner considered JP '932 as teaching the glow plug of claim 1 substantially as claimed, including inward protrusion 33 and a combustion pressure sensor having ring-shaped pressure-sensitive elements 28, 29. The Examiner relied on JP '237 as disclosing a glow plug having an inward protrusion 4a and an outward protrusion 15 and pressure sensitive element 14. The reason for rejection was that it would have been obvious to modify the glow plug of JP '932 to include an outward protrusion portion as taught by JP '237 in order to support the pressure sensitive element.

As to method claim 6, the Examiner considered that the method of making the glow plug would have been obvious because JP '932 in view of JP '237 is said to disclose substantially all major elements of the invention.

The Examiner did not separately address independent claim 9 directed to a glow plug.

Applicants traverse, and respectfully request the Examiner to reconsider in view of the amendments to the claims in the following remarks.

In reference to Fig. 2, claim 1 (as originally filed) requires combustion pressure sensor 50 having a pressure-sensitive element 51 held between a front surface 151 of the inward protrusion 15 and a rear surface 231 of the outward protrusion 241 to generate an electrical signal in response to variations in stress applied thereto. Furthermore, the cylindrical housing 10 includes the inward protrusion 15, whereas the center electrode 2 includes the outward protrusion 241. As defined in claim 9, this specific arrangement allows the pressure sensor to convert axial displacement of the sheath or the sheath and the heater due to variation in combustion pressure into an electrical signal. The glow plug is configured so that compressive stress is increasingly applied to the pressure-sensitive element by screwing the glow plug into the plug hole, and the compressive stress further increases with an increase in combustion pressure. The invention solves a problem of the prior art in which the output of the piezoelectric element cannot be maintained. The present invention provides a glow plug having a built-in combustion pressure sensor capable of detecting variations in combustion pressure without fail. See [0004] and [0005].

Turning to the cited prior art, structural feature 33 of Fig. 2 of JP '932 is an inward protrusion, not an outward protrusion. Likewise, 4a in JP '237 is an outward protrusion (not an inward protrusion).

JP '932 teaches a glow plug having a cylindrical body 20 formed with a flange 23, a cylindrical sheath tube 24 arranged in the cylindrical housing 20 and formed with an outward protrusion (flange) 26, a spring 27 held between the flanges 26, 27, a cap 22 attached to the flange 23 and piezoelectric elements 28, 29 held between the outward protrusion 26 and the cap 22. When there is an increase in combustion pressure, the sheath tube 24 moves against the tension of spring 27 such that the piezoelectric elements 28, 29 are compressed between the flange 26 and the cap 22 to generate an electrical signal. The glow plug of JP '932 is fixed to an engine cylinder block by means of thread 21 cut in an outer cylindrical surface of the housing 20.

JP '237 teaches a glow plug having an inner housing 4 formed with an outward protrusion 4a, an outer housing 5, a piece 15 drive fitted in the housing 5, and a piezoelectric element 14 disposed between the outward protrusion 4a and the inward protrusion (i.e., the drive-fitted piece) 15. Combustion pressure is exerted on the inner housing 4 and then transmitted from the protrusion 4a to the piezoelectric element 14, such that the piezoelectric element 14 is compressed between the protrusions 4a, 15 to generate an electrical signal. The glow plug of JP '237 is fixed to an engine cylinder block by means of a thread 5a cut in an outer cylindrical surface of the housing 5.

That is, the glow plug of JP '932 has piezoelectric elements 28, 29 held between inward protrusion 22 and outward protrusion 26 (flange) under compressive force via spring 27. Inward protrusion (flange) 22 is fixed to body (housing) 20. However, differing from claim 1, flange 26 (inner protrusion) is not part of the center electrode 31 and is not directly fixed to the center electrode.

Fig. 1 of JP '237 shows pressure sensitive element 18 held between a front surface of a partial inward protrusion 5c forming part of housing 5 and a rear surface of outward protrusion 4a attached to an inner sleeve 4. Differing from claim 1, outward protrusion 4a is not fixed or integrally joined with center electrode 6, just as in JP '932.

Thus, to more clearly distinguish over the cited prior art, claim 1 has been amended to recite that the outward protrusion is fixed to the center electrode or integral with the center electrode (see Paragraph [0031]). None of JP '932 and JP '237 describes an outward protrusion fixed to or integral with the center electrode.

In the glow plug of the present invention (claims 1, 6), by contrast, the piezoelectric element is held between the inward protrusion of the housing and the outward protrusion of the center electrode. Because the center electrode is smaller in diameter than the housing and the sheath (which correspond to the sheath tube 24 of JP '932 and the inner housing 4 of JP '237), the present invention allows for downsizing of the glow plug with the outward protrusion being fixed to or integral with the small-diameter center electrode.

Claim 9 has been amended to recite that the rear end portion of the sheath is axially apart from the threaded portion of the housing.

In contrast, the thread 21 of housing 20 is located at a position axially corresponding to the sheath 24 in JP '932. In JP '237, the thread 5a of the housing 5 is also located at a position axially corresponding to the sheath 2. In this arrangement of JP '932 and JP '237, the compressive stress cannot be effectively applied to the piezoelectric element by screwing the glow plug into a plug hole of the cylinder block.

On the other hand, in the glow plug of present claim 9, the threaded portion 14 is formed between the front 11 and rear end 12 portions of the housing 10, and the rear end portion of the sheath 3 is fitted in the front end portion of the housing. See Fig. 1A. Namely, the rear end portion of the sheath is axially apart from the threaded portion of the housing in the claimed glow plug. Thus, a large flexure arises between the sheath rear end portion and the housing threaded portion when the glow plug is screwed into the plug hole, such that compressive stress is effectively applied to the piezoelectric element.

In view of the above remarks and amendment of the claims, it is respectfully submitted that a person of ordinary skill would not have been led to the presently claimed invention or unexpected advantages associated therewith from the combined teachings of JP '932 and JP '237. Accordingly, it is respectfully submitted that claims 1-10 are patentable over JP '932 and JP '237, and withdrawal of the foregoing rejection under 35 U.S.C. § 103(a) is respectfully requested.

Withdrawal of all rejections and allowance of claims 1-10 is earnestly solicited.

In the event that the Examiner believes that it may be helpful to advance the prosecution of this application, the Examiner is invited to contact the undersigned at the local Washington, D.C. telephone number indicated below.

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Application No. 10/801,196

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The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



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